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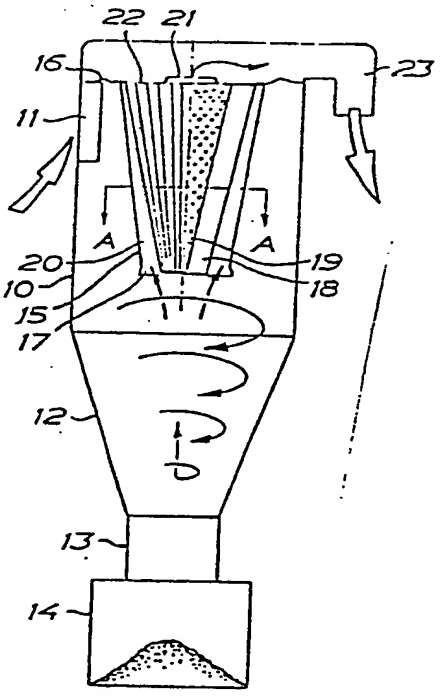
(57) Abstract

In a cyclone separator a folded filter unit (18) is arranged inside the central tube (15) of the cyclone separator said tube completely enclosing the filter unit with an annular gap (20) provided between the filter unit and the central tube.



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CYCLONE SEPARATOR WITH FILTER UNIT

The invention relates to dust separators and more particularly to a cyclone separator with filter unit for separating dust from gas, the filter unit being located in the central tube of the cyclone separator with an annular gap provided between the filter unit and the central tube.

Cyclone separators are frequently used for separating impurities from a gas (air). The cyclone separator includes a cylindrical housing with a tangential gas inlet and a bottom cone arranged at the lower end, which connects with a dust outlet. Inside the housing a central tube is provided which connects with a gas outlet and is located in the central section of the cyclone separator. The tangential gas inlet of the cyclone separator produces a rotational movement of the incoming gas and forces the dust particles towards the cylindrical surface of the cyclone separator. The rotating particles are actuated by the centrifugal force, the gravity and the movement of the gas towards the gas outlet (the central tube).

The separated dust rotates downwards towards the lower portion of the cyclone separator, the bottom cone and the dust outlet, while the purified gas passes through the central tube (the outlet). Since it is not possible to reduce unlimitedly the rotational movement and the gas velocity towards the outlet, the separating effect of a cyclone separator is always limited due to physical conditions. The rotational movement in the central tube can be slightly limited by means of vanes or wings in the central tube, and as a consequence thereof the separating efficiency of the cyclone separator will be increased.

Sometimes the cyclone separator is combined with a filter unit for cleaning the gas from such particles as are not separated in the cyclone separator by the rotational movement.

Several cyclone separators are available on the market, wherein attempts have been made to provide said combination in order to obtain a small apparatus volume. However, the embodiments of such combined separators, which have been presented so far, have a low efficiency due to the fact that the filter unit requires a large space, which negatively affects the design of the cyclone separator.

For the purpose of providing a compact dust separator comprising a cyclone separator and a filter unit, while obtaining maximum separating effect, the cyclone separator according to the invention has obtained the characteristics according to claim 1.

By this arrangement the filter material of the filter unit is utilized for reducing the rotational movement and the air velocity in the central tube. The efficiency and the separating effect preferably as far as small dust particles in the cyclone separator are concerned, will be considerably increased, the filter will be loaded by a smaller proportion of dust, and the flow losses will be reduced. At the same time a large filter area is obtained by the folded filter construction, which reduces pressure drop losses over the filter unit. The wrinkled passage between the central tube and the filter functions as a stabilizer for the gas.

In order to explain in more detail the invention embodiments will be described below reference being made to the accompanying drawing in which

FIG. 1 is a diagrammatic vertical cross sectional view of the cyclone separator,

FIG. 2 is a cross sectional view along line A-A in FIG. 1,

FIG. 3 is a side view of the filter unit,

FIG. 4 is a side view of the central tube,

FIG. 5 is a comparing diagram illustrating the separating efficiency of cyclone separators of different types, and

FIG. 6 is a vertical cross sectional view of the central tube in a modified embodiment thereof.

The cyclone separator comprises a cylindrical housing 10 with a tangential inlet 11 for gas (air) with dust entrained therein. At the bottom the housing 10 connects with a bottom cone 12 and a dust outlet 13 which then connects with a dust magazine 14. A central tube 15 is arranged inside the housing, said tube being suspended by means of a rubber diaphragm 16 attached to the housing. The central tube tapers towards the lower end thereof, the inlet end, and has a flaring 17 at said end. A filter 18 also tapering towards the lower, closed end thereof, is arranged inside the central tube coaxially therewith. The filter too is supported by the diaphragm and preferably is attached so as to be replaced. It can consist of a paper or textile material or of a metal netting, a ceramic material or a plastic material or also of different combinations of these materials according to the principles generally applied in the filter technique. The filter forms longitudinal folds and is braced on the inside thereof by means of a perforated tube 19 of a rigid material (cardboard, metal or plastic), which supports the filter at the inside folds. Also this tube is supported by the diaphragm and it can be constructed to form a unit with the filter. Between the filter and the central tube

an annular gap 20 is provided. An opening 21 in a wall 22 closing the central tube at the upper end thereof, connects the interior of the tube 19 with an outlet 23 for gas which has been purified in the cyclone separator.

The contaminated gas passes through the inlet 11 of the cyclone separator and rotates along the housing 10 of the cyclone separator. Due to the centrifugal force and the gravity impurities (dust particles) are forced downwards to the dust magazine 14 were they are separated. The purified gas, still rotating, raises towards the inlet of the central tube 15 were the gas is forced to pass over the folded surface of the filter 18 in the gap 20. The folded filter surface stabilizes the gas by retarding remaining rotational forces so that a laminar gas flow continues through the outlet 23 of the cyclone separator.

The fine dust particles which cannot be separated by cyclone action, stick to the filter surface. Due to the folded filter construction the filter area is relatively large and the flow losses are relatively small such that large amounts of fine dust can be separated in the filter construction proper. When the gas flow is shut off the fine particles come lose from the folded filter surface and fall down to the separated dust in the dust magazine 14.

Due to the fact that the filter is folded in the longitudinal direction thereof a highly effective cyclone separator is provided. The vanes are replaced by the filter operating as means for retarding the central cyclone vortex, the separating efficiency of the cyclone separator being increased as a consequence thereof. This is illustrated in FIG. 5 were the horisontal axis indicates the particle size in µm

and the vertical axis indicates the separating efficiency in per cent. The graph A relates to a cyclone separator having no filter unit, the graph B relates to a cyclone separator having a cylindrical folded filter unit and indicates the separating efficiency of the cyclone separator proper (not the filter), and the graph C in the same manner as the graph B indicates the separating efficiency of a cyclone separator having a folded filter unit which tapers towards the lower end thereof and is located in a central tube tapering downwards, as in the embodiment shown and described. The graphs are based on laboratory tests. Due to an increased separating efficiency of the cyclone separator the filter will be loaded to a considerably lower degree, which means that the flow losses will be reduced.

The central tube 15 together with the filter 18 forms a compact unit which can be shaken in a simple manner for cleaning the filter surface thanks to the suspension by means of a rubber diaphragm 16. The dust particles which stick to the folded filter surface then fall down easily through the central tube and through the lower portion of the cyclone separator to the dust magazine. Since the folded filter is conical in relation to the central tube (tapering towards the lower end) the filter unit can be more easily cleaned by shaking because the inclination of the filter facilitates the drainage of the dust.

The ideal construction seems to be that of the embodiment shown and described wherein the central tube is made slightly conical and also the filter unit is conical but with a larger angle. Referring to FIGS. 3 and 4 α should range from 0 to 30° and β from 0 to 25°. Furthermore, $\alpha \geq \beta$. At the test forming the basis for the graph C, the angles were

α = 8° and ß = 5°.

In the embodiment according to FIG. 6 several filters 18 of the construction described above are arranged in the central tube 15 which in this case extends below the lower ends of the filters the part of the central tube extending below the filters, being provided with wings or vanes 24 at the inside thereof.

CLAIMS

1. Cyclone separator with filter unit (18) for separating dust from gas, the filter unit being located in the central tube (15) of the cyclone separator with an annular gap (20) provided between the filter unit and the central tube, c h a r a c t e r i z e d in that the filter unit (18) is folded longitudinally thereof.

2. Cyclone separator as claimed in claim 1, c h a r a c t e r i z e d in that the filter unit (18) is conical and tapers towards the inlet end of the central tube (15).

3. Cyclone separator as claimed in claim 1 or 2, c h a r a c t e r i z e d in that the enclosing central tube (15) is conical and tapers towards the inlet end thereof.

4. Cyclone separator as claimed in any of claims 1 to 3, c h a r a c t e r i z e d in that the enclosing central tube (15) is flared (17) at the inlet end thereof.

5. Cyclone separator as claimed in claim 2 or 3, c h a r a c t e r i z e d in that several filter units (18) are arranged in parallel in the central tube (15).

6. Cyclone separator as claimed in any of claims 1 to 5, c h a r a c t e r i z e d in that the central tube (15) at the inside thereof is provided with wings or vanes (24).

7. Cyclone separator as claimed in any of claims 1 to 6, c h a r a c t e r i z e d in that the filter unit (18) and the enclosing central tube (15) are suspended by means of an elastic diaphragm (16).

8. Cyclone separator as claimed in any of claims 1 to 7, c h a r a c t e r i z e d in that the filter unit (18) at the inside thereof is braced by means of a perforated support tube (19) for the inner filter folds.

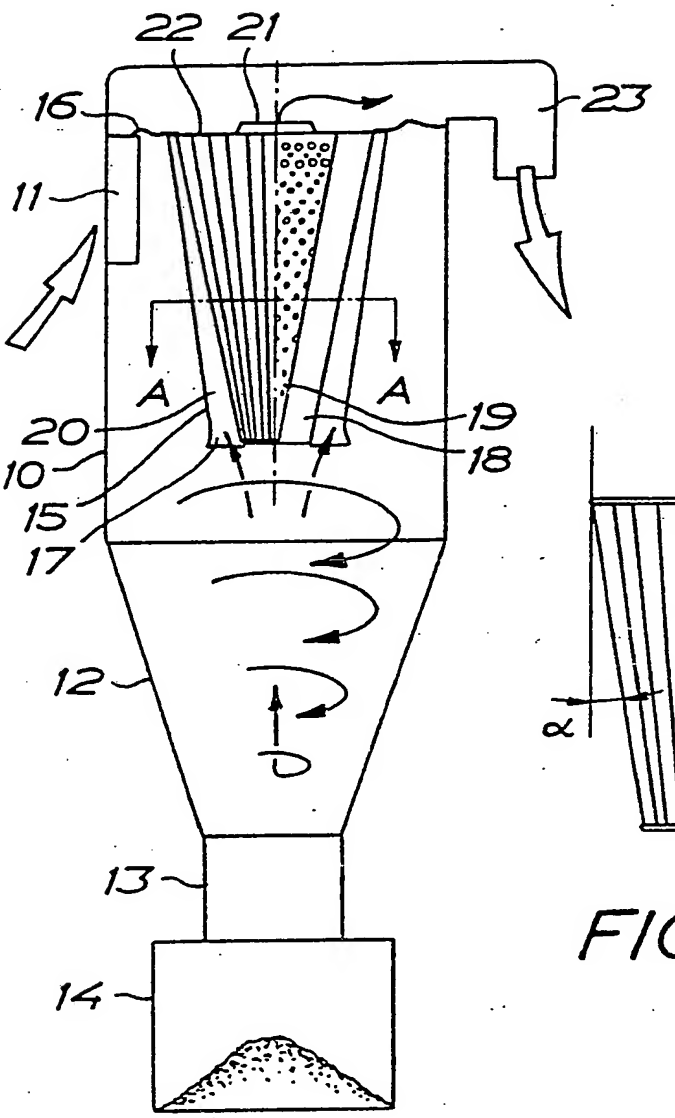

FIG. 1

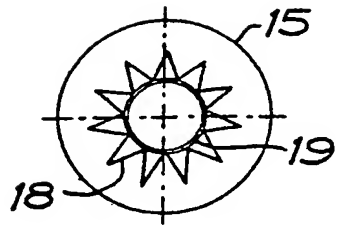

FIG. 2

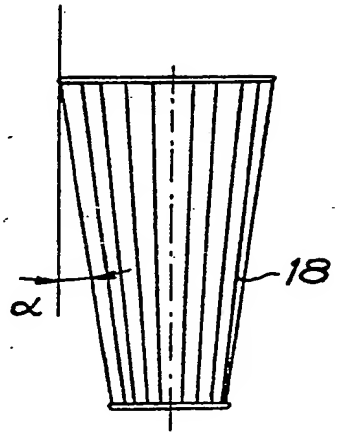

FIG. 3

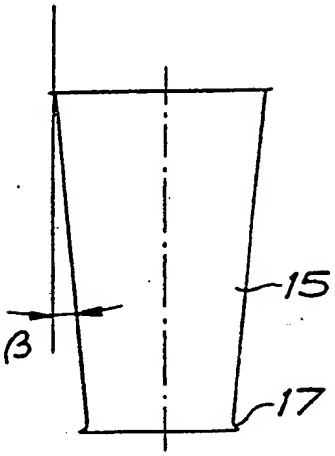

FIG. 4

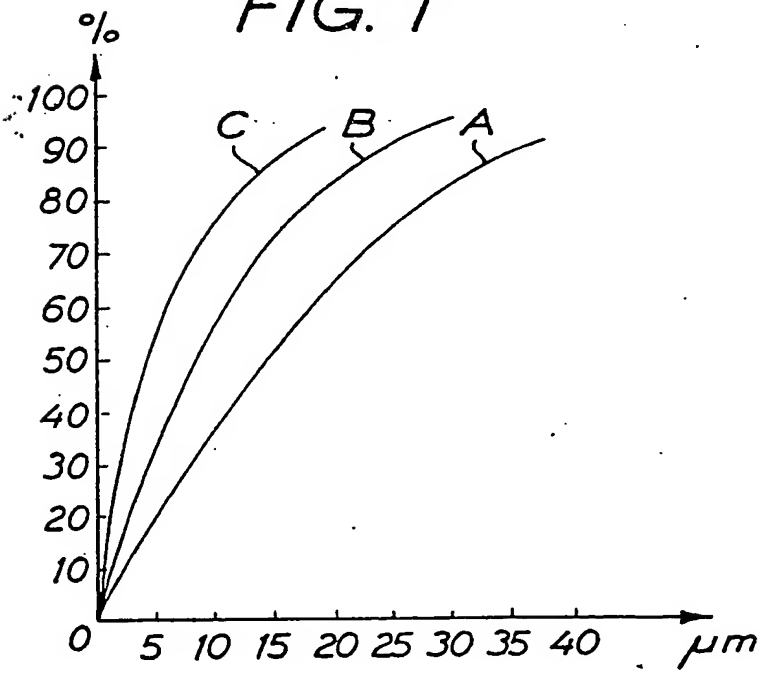

FIG. 5

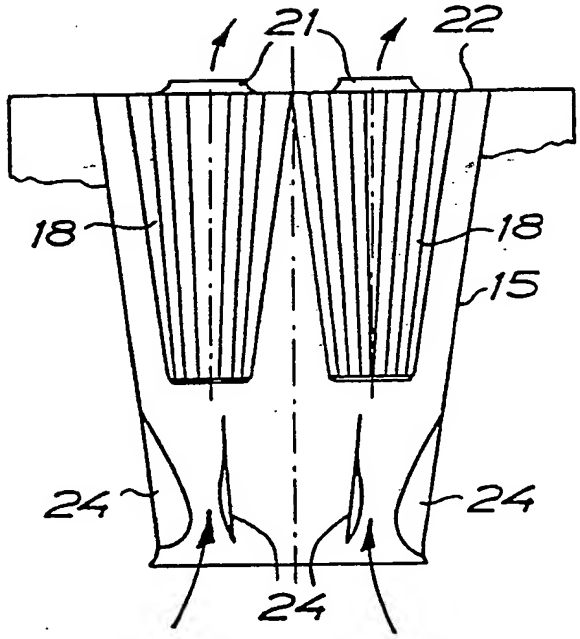

FIG. 6

INTERNATIONAL SEARCH REPORT

International Application No PCT/SE83/00130

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC 3

B 01 D 50/00

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
IPC 3	B 04 C 5/12,13, B 01 D 50/00, 46/52
US Cl	209:211

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in the Fields Searched [5]

SE, DK, NO, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category [6]	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
X	Patent Abstracts of Japan, abstract of JP 52-43 173 , published 1977-04-04	
X	DE, B, 1 607 592 (SIEMENS AG) 30 August 1966	
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IV. CERTIFICATION

Date of the Actual Completion of the International Search [9]	Date of Mailing of this International Search Report [9]
1983-06-22	1983 -07- 04
International Searching Authority [1]	**Signature of Authorized Officer [20]**
Swedish Patent Office	C Westberg

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